

Authors

George R. Ahearn

Systems Development Division, San Jose, California

Mr. Ahearn is a Senior Engineer in the San Jose Laboratory. He received a B.E.E. degree from Villanova University in 1956 and an M.E.E. degree from Catholic University in 1959. He joined IBM in Endicott, New York, in 1958 where he was assigned to Product Development work on the 1400 Series Systems. Subsequently, he held management responsibility for the IBM 1285 Optical Journal Tape Reader development. In 1967 he transferred to the San Jose Laboratory and since then he has been responsible for the IBM 2835 Control Unit development. Mr. Ahearn is a member of the IEEE.

Byron R. Brown

Research Division, San Jose, California

Mr. Brown is a staff member in the advanced storage technology group of the San Jose Research Laboratory. He received a B.S. degree in Engineering Physics from the University of California, Berkeley, in 1965 and an M.S. in Physics from the California Institute of Technology in 1967. He joined the Research Division in San Jose in 1966 and initially worked on the development of computer-generated holograms and spatial filters.

Robert H. Collins

Components Division, East Fishkill, New York

Mr. Collins joined the Components Division of IBM in Poughkeepsie in 1965 as a Staff Engineer and became Project Engineering Manager of Photoresist and Thin Film Engineering in 1966. He was promoted to Process Development Engineering Manager of the Current Memory Component Development Group in 1968 and to Senior Engineer in 1969. In 1970, Mr. Collins became Manufacturing Engineering manager for CP Memory Manufacturing. After obtaining a B.S. in Chemistry, Mr. Collins worked as an engineer with RCA's Chemical and Physical Laboratory in Lancaster, Pennsylvania, from 1957 to 1963. In 1963, he joined Machlett Laboratories and worked in power tube development. In January of 1964, he joined the United Aircraft Corp. as a Project Engineer.

Yitzhak Dishon

Systems Development Division, San Jose, California

Mr. Dishon is a Senior Associate Engineer in the San Jose Laboratory. He received the B.S. in Electronic Engineering from California State Polytechnic College, San Luis Obispo, in 1966 and the M.S. degree in Engineering from University of Santa Clara in 1970, under the IBM Graduate Work-Study Program. From 1953 to 1962 he worked with Israel Post, Tele-

graph, Telephone and Radio, Haifa, on telephone and telegraph multichannel communication systems. He joined IBM in San Jose in 1966 to work on disk file and communications adapter attachments to small scientific computer systems. Since 1968 he has been with the Advanced Disk Storage Facilities group, where he worked on the 3830 Control Unit. Mr. Dishon is a member of the IEEE.

Lawrence V. Gregor

Components Division, East Fishkill, New York

Dr. Gregor is a Senior Chemist in a component technology development group at the Components Division Laboratory in East Fishkill. He joined IBM in 1961 at the Thomas J. Watson Research Center before moving to the Components Division in 1965. His degrees are all in Chemistry—the B.S. and M.S. in 1954 and 1959, respectively, from the Pennsylvania State University, and the Ph.D. in 1961 from the University of California at Berkeley.

Edward G. Grochowski

Components Division, East Fishkill, New York

Dr. Grochowski is Manager of Metallurgy-Process Technology at the Components Division Laboratory in East Fishkill. He has been with IBM since 1961. His education includes a B.S. degree from the University of Delaware in 1959, an M.S. from the University of Michigan in 1961, and a Ph. D. from New York University in 1971, all in Chemical Engineering. He was associated with the University of Michigan Semiconductor Materials Research Laboratory and was involved in exploratory work with binary and ternary crystalline chalcogenides, particularly the indium tellurides for both thermoelectric and semiconductor applications. At N.Y.U. he investigated the relationships between morphology and electrical properties of amorphous selenides. At IBM he has been involved with process development for silicon material technology in the field of epitaxy and diffusion. His primary interests have been in developing an understanding of materials and process variables and their effects on resulting electrical characteristics. A major accomplishment of this has been a contribution to the monolithic memory process technology for IBM Systems 360 and 370. Dr. Grochowski is a member of the Electrochemical Society.

Anthony Hassitt

Data Processing Division, Scientific Center, Palo Alto, California

Dr. Hassitt is a staff member at the Palo Alto Scientific Center. He received a B.A. in 1951 and a Ph.D. in 1955, both from Oxford University, England. He worked for the U.K. Atomic Energy Authority from 1954 to 1963, on the application of computers to problems in reactor physics. He taught and did research at the University of California, San Diego from 1963 until he joined IBM in 1967. During the past three years he has been working on the use of microprogramming, particularly for the emulation of APL. He is the author of the book "Computer Programming and Computer Systems."

Donald J. Hatfield

Data Processing Division, Scientific Center, Cambridge, Massachusetts

Mr. Hatfield received an S.B. in Mathematics and History in 1960 from MIT. Before joining IBM in 1965 he did research

into the psychology of visual perception and was involved with documentary film-making. Since joining IBM, he has done work in operations research and in sequencing problems. He has also investigated the application of optimization techniques to computer systems, in particular the matching of program structures to relocation hardware. He is presently investigating problems in data description and studying local structure invariance in protein molecules.

Robert E. Jones, Jr.

Systems Development Division, San Jose, California

Dr. Jones is currently working in thin film technology in the Systems Development Division laboratory in San Jose. He received his A.B. in Chemistry in 1953 from Columbia University and a Ph.D. in Chemistry from the University of California at Berkeley in 1957.

Wilhelm Jutzi

Zurich Research Laboratory, Rüschlikon, Switzerland

Dr. Jutzi is currently working on very-high-packing-density MESFET (Metal-Semiconductor Field-Effect-Transistor) memory chips at the Zürich research laboratory, where he joined a group studying thin film memories in 1961. Subsequently, he has also investigated various memory devices during temporary assignments in the IBM laboratories in Hursley, England and Boeblingen, Germany. After studies at the University of Grenoble in France, he received the B.S. degree in 1955, the M.S. degree in 1958 and the Ph.D. degree in 1962, all in Electrical Engineering, from the Technical University of Darmstadt, Germany. Dr. Jutzi is a member of the Nachrichten Technische Gesellschaft. In 1963 he received the NTG award for his work on short inhomogeneous transmission lines as microwave absorbers.

Thomas B. Light

Thomas J. Watson Research Center, Yorktown Heights, New York

Dr. Light is a member of the Exploratory Technology group at the Thomas J. Watson Research Center, where he joined IBM in 1965. His education includes a B.S. in Physics from Antioch College, 1951; an M.S. in Physics from Illinois Institute of Technology, 1954, and a Ph.D. in Materials Science from Yale University, 1966. He was a member of the technical staff at Bell Telephone Laboratories from 1953 to 1962. He is a member of the American Physical Society, American Institute of Metallurgical Engineers, American Vacuum Society, Electrochemical Society, Institute of Electrical and Electronic Engineers, and the American Association for the Advancement of Science.

Leonard E. Lyon

Data Processing Division, Scientific Center, Palo Alto, California

Mr. Lyon is an Advisory Programmer at the Palo Alto Scientific Center. He has been involved in microprogramming since joining IBM in November 1969 and has worked on the space management mechanism of an experimental APL machine. The bulk of his computer experience was gained during employment at MIT. Mr. Lyon received his B.S. in Industrial Management, 1963 and his M.S. in Mathematics 1969 from MIT.

Leon I. Maissel

Systems Development Division, Poughkeepsie, New York

Dr. Maissel came to IBM in 1960 and, prior to his present position, was manager of Basic Studies (thin films). He received the B.Sc. in Physics and Chemistry in 1949 and the M.Sc. in Physics in 1951 from the University of Capetown, South Africa; and the Ph.D. in Physics in 1955 from the Imperial College, London. He joined the Philco Corporation in Philadelphia in 1956, where he worked on metal-semiconductor contacts. He is currently a member of the Systems Development Division where he is working on system design based on array logic. Dr. Maissel is co-editor of the book "Handbook of Thin Film Technology."

William D. North

Components Division, East Fishkill, New York

Mr. North has been involved in various aspects of monolithic memory development since he joined IBM at the East Fishkill laboratory in 1966. He was promoted to Manager of a product characterization and test group in 1967 and achieved his current position in January 1971. He has company-wide product engineering responsibility for a monolithic main memory project now under development. Before coming to IBM, he did semiconductor research work at the Sprague Electric Co. and integrated circuit development at Sperry Semiconductor. Mr. North received his B.S.E.E. from Cornell University in 1961.

Arnold Reisman

Thomas J. Watson Research Center, Yorktown Heights, New York

Dr. Reisman is currently Manager of the Exploratory Technology area in the Applied Research Department at the T. J. Watson Research Center in Yorktown Heights, and has been with IBM since 1953 when he joined the staff at the Watson Laboratory at Columbia University. He holds a B.S. from the City College of New York (1949), an M.S. from Brooklyn College (1953), and a Ph.D. from the Polytechnic Institute of Brooklyn (1958). He has published some 45 technical papers, is the author of a chapter in the book, "High Temperature Oxides" and the author of the book, "Phase Equilibria", and has been a Guest Editor of the *Proceedings of IEEE*. He is a Fellow of the American Institute of Chemists, a member of the American Chemical Society and the Electrochemical Society. He is Vice Chairman of the Electronic Materials Committee, AIME, Vice Chairman of the Gordon Conference on Crystal Growth, 1973, a member of the IEEE Committee on Electronic Materials, and a member of the Editorial Board of the Journal of Electronic Materials.

Claus H. Schuenemann

Systems Development Division, Boeblingen, Germany

Dr. Schuenemann is Manager of the Advanced Technology Systems Group at the laboratory in Boeblingen. Since joining IBM in 1963, he has worked on systems design and technology. His education includes a Dipl.-Ing. degree, 1955, and the Dr.-Ing., 1965, both from the Technische Hochschule Darmstadt, Germany. From 1955 to 1963 he worked with Allgemeine Elektrizitäts-gesellschaft. Dr. Schuenemann is a member of the Nachrichten-Technische Gesellschaft.

Victor J. Silvestri

Thomas J. Watson Research Center, Yorktown Heights, New York

Mr. Silvestri is a staff member at the Thomas J. Watson Research Center in Yorktown where he is engaged in vapor growth of thin films. He joined IBM at the laboratory in Poughkeepsie in 1956, to work on crystal growth of II-V semiconductors. Since 1960 he has been involved in the area of vapor growth of III-V semiconductors and germanium. He received a B.A. in Biology in 1954 from Alfred University. Mr. Silvestri is a member of the Electrochemical Society.

Robert N. Snively

Systems Development Division, San Jose, California

Mr. Snively is a Senior Associate Engineer in the Advanced Disk Storage Facilities department at the San Jose Laboratory. He holds B.S. and M.S. degrees, both in Electrical Engineering, from Stanford University, 1965. Mr. Snively taught electronics at Universidad Technica del Estado (State Technical University), Santiago, Chile while with the Peace Corps. Upon his return in 1968 he joined IBM where he participated in the design of the 3830 Control Unit. He is currently on an assignment at IBM's Laboratory in Böblingen, Germany.

Charles L. Standley

Components Division, East Fishkill, New York

Mr. Standley is an Advisory Chemist in the product assurance area of the laboratory at East Fishkill, where he is currently working on reliability evaluation of FET devices. Since joining IBM in 1960, he has also worked in the areas of thin film physics and rf sputtering physics. His education includes a B.S. from Kansas State College in 1956 and an M.S. in Chemical Physics from the University of Arkansas in 1958. Mr. Standley is a member of the American Chemical Society and the Electrochemical Society.

Hwa-Nien Yu

Thomas J. Watson Research Center, Yorktown Heights, New York

Dr. Yu is a member of the Applied Research Department at the Research Center, where he is conducting experimental studies of solid-state devices. He was hired by IBM in 1957 at the research laboratory in Poughkeepsie and transferred to the Advanced Systems Development Division's Mohansic Laboratory in 1959; he has been at the Research Center since 1962. Dr. Yu's degrees in Electrical Engineering were all obtained at the University of Illinois—the B.S. in 1953, the M.S. in 1954, and the Ph.D. in 1958. He is a member of Sigma Xi, Pi Mu Epsilon, RESA and the IEEE.

❖ *Papers:*

Multi-fluid Subdued Boiling; Theoretical Analysis
of Multi-fluid Interface Bubbles
by *S. Oktay* 342

A Procedure for Implementing the Fast Fourier
Transform on Small Computers
by *J. W. Hartwell* 355

Generation of Synchronous Data Transmission
Signals by Digital Echo Modulation
by *M. F. Choquet and H. J. Nussbaumer* 364

Activation Energy for Electromigration in
Aluminum Films Alloyed with Copper
by *M. C. Shine and F. M. d'Heurle* 378

Design of Logic Circuit Technology for IBM
System/370 Models 145 and 155
by *P. E. Fox and W. J. Nestork* 384

The IBM 3803/3420 Magnetic Tape Subsystem
by *J. W. Irwin, J. V. Cassie and H. C. Oppeboen* 391

Thermal Problems of the CW Injection Laser
by *R. W. Keyes* 401

❖ *Communications:*

Ultra-high-speed Operation of Josephson
Tunneling Devices
by *H. H. Zappe and K. R. Grebe* 405

Synchronization in a Wideband Optical Data
Transmission System
by *E. M. Philipp-Rutz* 408

Direct Technique for Improving a Matrix Inverse
by *G. A. Sitton* 413

• *Papers on exploratory semiconductor technology:*

- A Self-Isolation Scheme for Integrated Circuits
by M. B. Vora 430

- Design and Development of an Ultralow-Capacitance, High-Performance Pedestal Transistor
by H. N. Ghosh, K. G. Ashar,
A. S. Oberai and D. DeWitt 436

- Planar Mesa Schottky Barrier Diode
by N. G. Anantha and K. G. Ashar 442

- Electron Beam Fabrication of Micron Transistors
by S. Magdo, M. Hatzakis and C. H. Ting 446

- Experimental Evaluation of High Energy Ion Implantation Gradients for Possible Fabrication of a Transistor Pedestal Collector
by J. F. Ziegler, B. L. Crowder
and W. J. Kleinfelder 452

• *Papers on arsenic-emitter transistors:*

- An Arsenic Emitter Structure for High-Performance Silicon Transistors
by H. N. Ghosh, A. S. Oberai,
J. J. Chang and M. B. Vora 457

- Arsenic Source Vapor Pressure Kinetics and Capsule Diffusion
by J. S. Sandhu and J. L. Reuter 464

- A Diffusion Model for Arsenic in Silicon
by T. L. Chiu and H. N. Ghosh 472

• *Letter to the Editor:*

- On the Relationship of Resistivity to Arsenic Concentration for Heavily Doped n-type Silicon
by T. L. Chiu and H. N. Ghosh 477

• *Communication:*

- Numerical Calculation of Magnetic Fields in the Vicinity of a Magnetic Body
by A. E. Ruehli and D. M. Ellis 478

IBM

The IBM Journal of Research and Development is regularly indexed and abstracted by Science Abstracts (I.E.E.-Britain), Chemical Abstracts, The Engineering Index, Physikalische Berichte, Metals Abstracts, Mathematical Reviews, Computing Reviews, Computer Abstracts (Technical Information Company, Ltd.-Britain), Bulletin Signaletique (C.N.R.S.-France), Academy of Sciences of the USSR Institute of Scientific Information, Instrument Abstracts (British Scientific Instrument Research Association), Automatic Subject Citation Alert, Documentation Abstracts, Applied Mechanics Reviews and Data Processing Digest. Reproductions of the Journal by years are available on positive microfilm from University Microfilms, 313 North First Street, Ann Arbor, Michigan 48103.